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# HIGHWAY GEOLOGY

# PHILADELPHIA to PITTSBURGH

*By*

BRADFORD WILLARD

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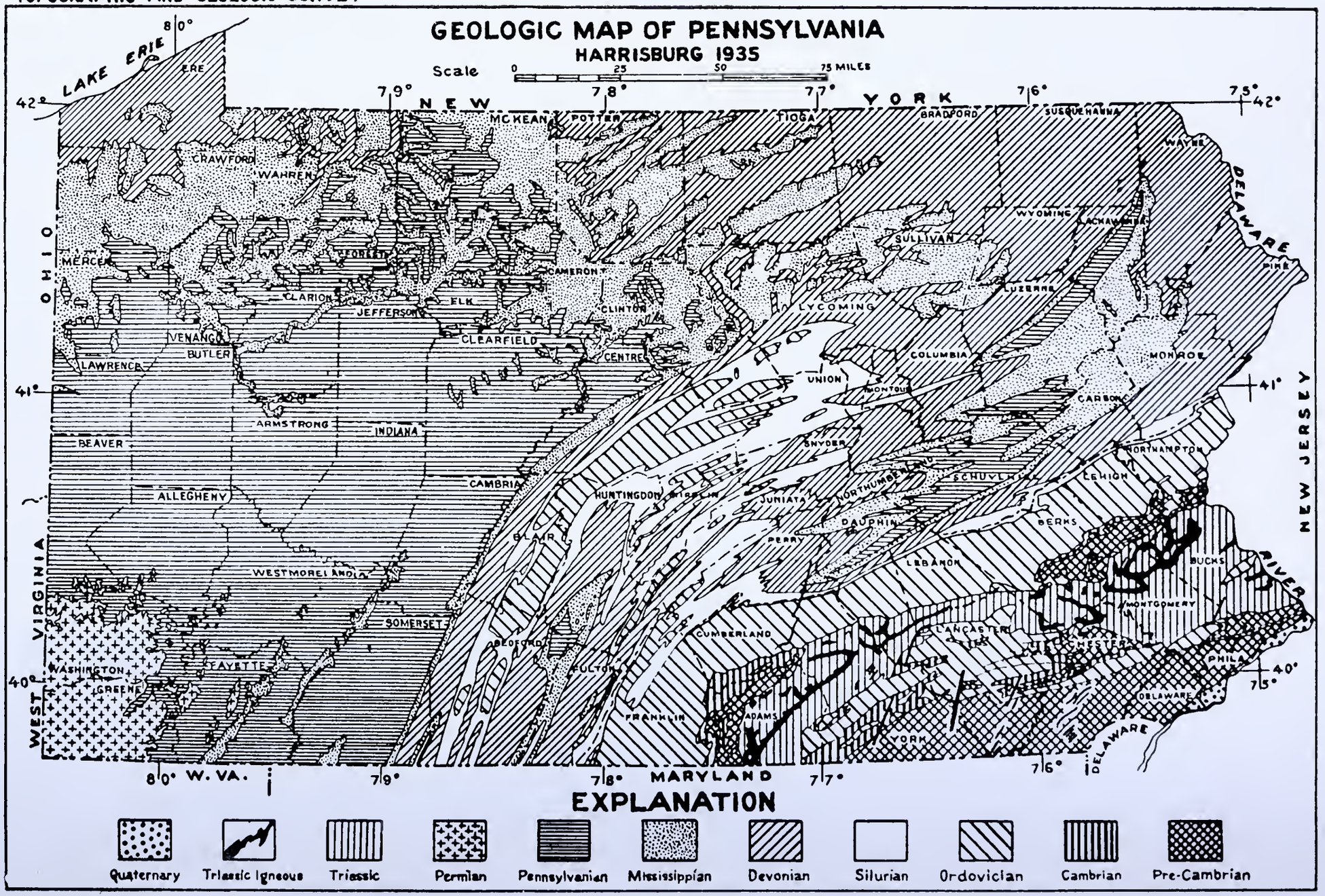
GEOLOGIC MAP OF PENNSYLVANIA
HARRISBURG 1935
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LAKE ERIE
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NEW YORK
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DELAWARE RIVER
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CLEARFIELD
BUTLER
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MONROE
UNION
MONTOUR
CARBON
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INDIANA
SNYDER
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FULTON
PHILA
WASHINGTON
FAYETTE
GREENE
DELAWARE
FRANKLIN
ADAMS
YORK
EXPLANATION
Quaternary
Triassic Igneous
Triassic
Permian
Pennsylvanian
Mississippian
Devonian
Silurian
Ordovician
Cambrian
Pre-Cambrian

# HIGHWAY GEOLOGY, PHILADELPHIA TO PITTSBURGH

BY

BRADFORD WILLARD

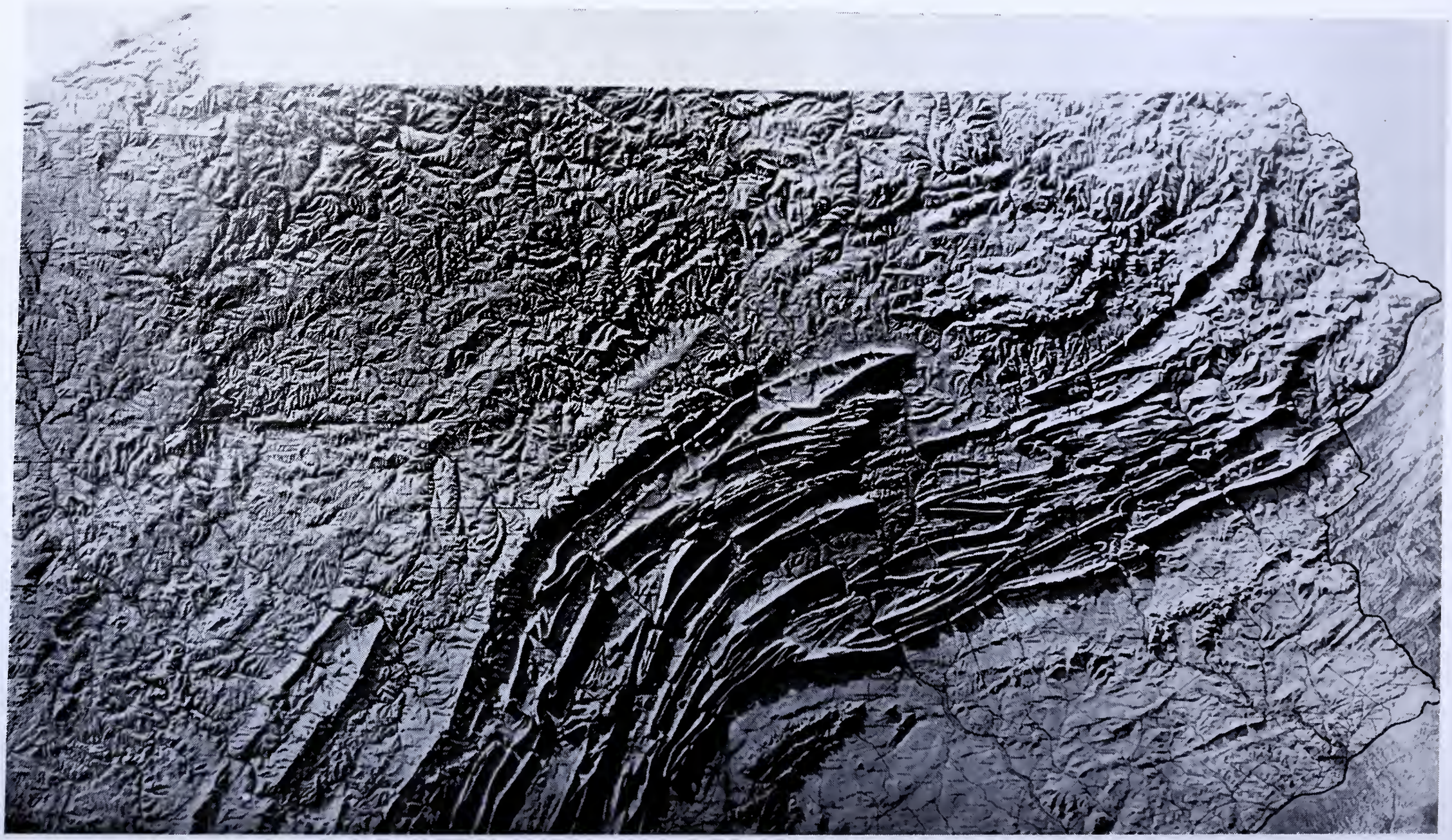
## INTRODUCTION

In response to a growing interest in the geology to be seen along the highways of Pennsylvania, a survey of U. S. Routes 30, 230, and 22, between Philadelphia and Pittsburgh by way of Lancaster, Harrisburg, Huntingdon, and Ebensburg was made by the author in 1935 and subsequently amplified, rechecked, and brought up-to-date. The original intent of this study was to record suitable locations for highway markers or signs briefly describing points of geologic interest. Pending the installation of such markers, this bulletin is published that the information may be available to those interested and as a supplement to the markers if they appear. This is one of a sequence of annotated guides covering the more important highways of the State. In this same field, guide books of local interest have already been published or are being prepared for the Susquehanna Valley, the Delaware Water Gap, Philadelphia, Pittsburgh, Reading, the Lehigh Valley, and the Upper Schuylkill Valley.

The schedule is printed to run from Philadelphia westward, but can be used in the reverse order as well. It is advisable to consult the geologic column, page 29, for data on the several formations. The list of references at the end of this account is selected from the extensive literature on the geology of Pennsylvania as a supplement to the contents of this bulletin. The description of the route within the city limits of Philadelphia, with the alternate routes suggested, was furnished by Mr. Charles K. Graeber, formerly with the Pennsylvania Topographic and Geologic Survey. The physiographic data and a few other suggestions were supplied or inserted by Dr. George H. Ashley, State Geologist. Dr. Charles Butts furnished data on the Lower Paleozoic rocks in the region of Water Street and westward therefrom.

## GENERAL DESCRIPTION OF THE ROUTE

*Philadelphia-Harrisburg.* Philadelphia, the third city of the United States (population 1,950,950), was founded 1682. It is located on one of the most marked geologic unconformities in eastern North America, a sharp contact between the ancient crystalline rocks of the Piedmont area and the young deposits of the Coastal Plain. The



**Relief map of Pennsylvania.**

central, southern and northeastern parts of the city are built on the Coastal Plain, here composed of sand, gravel and clay of the Cape May formation of late Pleistocene or glacial age. From City Hall, Philadelphia, elevation 47 feet, built upon the Cape May formation, one may go west on Market Street and cross over the Schuylkill to Lancaster Avenue. This, the "Lancaster Pike," is now part of U. S. Route 30, the Lincoln Highway. This route to the city line is completely built-up and reveals no rock exposures. If we could see beneath the pavement, we might observe, beginning at Lancaster Avenue and Market Street and continuing to 52nd Street, that the route traverses the Pensauken formation, loose sand and gravel deposits of Pleistocene age. Beyond 52nd Street, the route enters very ancient crystalline rocks, the Wissahickon mica schist and associated gneiss. These are exposed to the northeast in cuts of the Pennsylvania Railroad. At City Line, the highway is still in the schist and gneiss area.

A route of more scenic interest leads out of the city from the City Hall along the Parkway to the East River Drive. The Parkway traverses Cape May gravel and sand to the entrance of Fairmount Park at the Art Museum. Along this route are many notable buildings, including the Franklin Institute, the Academy of Natural Sciences, and the Public Library. At the end of the Parkway is the Art Museum, beyond which the East River Drive follows the Schuylkill River to City Line Bridge.

Along this drive, splendid exposures of the Wissahickon mica schist can be seen in cliffs 80 to 100 feet high, and just beyond the Girard Avenue Bridge, the road tunnels through these rocks. The schist is pre-Cambrian or early Paleozoic in age; authorities differ. Whichever it is, is of little consequence here, for hundreds of millions of years ago these rocks were laid down as sediments, and were subsequently folded and squeezed into their present altered state. The original bedding is largely destroyed by the development of the cleavage and schistosity which simulate, but are not parallel to, the ancient stratification. At the Falls of the Schuylkill, between Hunting Park Avenue and the Reading Railroad Bridge, is a small exposure of gneiss which was intruded into the schist. Here the route bears west (left) at the City Line Bridge. It should be noted, however, that the drive to the right enters a 200-foot deep gorge in the Wissahickon schist along Wissahickon Creek, one of the beauty spots of Philadelphia. It is from this locality that the Wissahickon schist takes its name. The steep, narrow gorge and the cliffs along the Schuylkill are the result of geologically recent uplift of the land which rejuvenated these streams and enabled them to cut their courses down through the ancient rocks.

Crossing City Line Bridge, one follows City Line Avenue to Lancaster Avenue (U. S. Route 30) at Green Hill Farms. City Line Avenue traverses, first the Wissahickon mica schist, then more of the intruding gneiss already seen along the River Drive. Subsequently, the route traverses the famous "Main Line" suburban district, marked by beautiful homes, many of them built of the local stone. Here, too, are institutions of higher learning, notably Haverford, Bryn Mawr

and Villa Nova colleges at the towns of those names. The road gradually rises to 450 feet elevation to cross the Piedmont Highlands physiographic province, an area underlain by the same ancient schists and gneisses that are exposed along the Schuylkill Valley. At Bryn Mawr this level upland surface is strewn with sand and gravel, a small remnant of a once widespread blanket of these stream gravels. At Rosemont the highway enters an area underlain by the Baltimore gneiss, a "formation" by some considered one of the oldest geologic units in this part of Pennsylvania. This is a banded and contorted, metamorphic rock that is, perhaps, in part sedimentary and in part igneous in origin. At Wayne appears dark, coarse gabbro which has been intruded into the Baltimore gneiss. Between Wayne and Berwyn roads lead northward a few miles to Valley Forge State Park. This locality will repay a visit. Not only is it of great national interest because of its historic moment, but the geology includes certain features of the Triassic, particularly very coarse conglomerates, better seen here than farther along on the trip.

West of Wayne the road crosses another belt of Wissahickon mica schist. Beyond Malvern (elevation 540 feet), still in the mica schist, the old road curves and descends the hill to pass under the Trenton cut-off of the Pennsylvania Railroad; the new road takes a straighter westward course. From this upland a magnificent view across Chester Valley is afforded. This is a long, narrow, limestone valley. It is bounded by the South Valley Hills of Wissahickon mica schist, and the North Valley Hills of Cambrian quartzite. The road descends the South Valley Hills and enters the lowlands underlain by limestone of Cambrian and Ordovician ages. These rocks are more soluble and more readily eroded through solution than those of the hills to the north and south. The valley is occupied by only small streams and is developed not so much by stream erosion as by the solvent action of underground waters. Because of this chemical erosion, there is left a thick deposit of clayey, residual soil, derived from the impurities in the limestone. Its color is usually reddish, due to the presence of insoluble iron compounds. These limestone residual soils are among the most valuable farm lands in the State of Pennsylvania.

Route 30 follows this fertile valley westward through Downingtown (elevation 260 feet) and Coatesville (340 feet). West of Coatesville after crossing over the Pennsylvania Railroad, a deep cut exposes the Harpers schist or phyllite. This formation belongs to the Lower Cambrian. It is a gray, sandy, micaceous schist with some harder beds of quartz schist and thin-bedded quartzite. The road climbs the flank of North Valley Hills composed of Chickies quartzite, the basal Cambrian sediment, and continues westward along the broad upland to Mine Ridge which attains a height of 843 feet near the Lancaster-Chester county line. Structurally, Mine Ridge is the north limb of an anticline. The hard, resistant Baltimore gneiss occupies the backbone of the anticline. Flanking this gneiss on both sides, younger formations dip north and south. The Cambrian Chickies quartzite with the Hellam conglomerate at its base forms the ridge immediately north of the road at Chester-Lancaster county line.

A mile west of the county line, the road descends rapidly through a gap in the Chickies quartzite, and near the railroad station of Gap enters another fertile lowland, the Lancaster Valley, floored by limestones of Cambrian and Ordovician ages. The much folded limestones seldom crop out. In this greater expanse of limestone occur gently rolling hills up to 300 and 400 feet above sea level. In Mine Ridge, about 3½ miles south of Kinzers, is the old Gap Nickel Mine. Copper ore was found here as early as 1718, and for 80 or 90 years the mine was worked for that metal. About 1852 the presence of nickel was also made known, and ten years later Joseph A. Wharton of Philadelphia, who had established a nickel refinery at Camden, N. J., successfully smelted the ore and shipped the matte from his refinery. In 1877 the average annual production of the Gap Mine was estimated at 7,200 short tons, carrying 1 to 3 percent nickel. The mine produced then about one-sixth of the total annual world output of nickel. The discovery of richer ores in New Caledonia and Sudbury proved the death knell of the Gap Mine; closed in 1893.

From Gap to Lancaster the highway traverses the valley limestones. These are also folded and faulted, and exposures are few. A quarry at the west end of Kinzers reveals the Vintage dolomite of early Cambrian age, and in the railroad cut just beyond is a fine exposure of black shale of the Kinzers formation, which in places contains trilobites of early Cambrian age. North of the road at Vintage is a low anticlinal hill of Cambrian quartzite. Just before entering Lancaster the highway crosses the valley of Conestoga Creek, a small stream that winds down to the Susquehanna River. The high, steep banks show it to be deeply entrenched following recent uplift of this region. Lancaster (population 59,900, elevation 365 feet) is the home of the Hamilton Watch Company, 2,000 employes, and the Armstrong Cork Company, 3,400 employes, and is a centre for printing, tobacco and textile industries. Here the route leaves U. S. 30 and follows U. S. 230 north. As one leaves Lancaster, the campus of Franklin and Marshall College lies on the left, beyond the railroad yards. Beyond Little Conestoga Creek the road crosses a hill of gray shale in which trilobites of early Cambrian age occur. A noted collection of these fine fossils was obtained from the Getz quarry, ½ mile to the south. The higher wooded hills to the left are of Cambrian quartzite, uplifted in an anticline. The highway crosses limestones of Cambrian and Ordovician ages for miles through Salunga and Landisburg and across Chickies Creek. At Mount Joy (elevation 400 feet), the road is on Ordovician (Beekmantown) limestone and continues westward on this formation. New road cuts show these rocks to advantage. North of Florin a hill of overlying Cocalico or Martinsburg shale, also of Ordovician age, reaches the road. Two miles east of Elizabethtown, the route enters the Triassic.

The continental sediments of the Triassic system occupy a broad belt from Maryland through Gettysburg and northeastward to the Delaware River. They have been faulted down into the limestone on their western margin. Today, thousands of feet of red sandstones and shales all dipping northwestward are displayed in Pennsylvania. In the

road cuts buff Triassic beds are also to be seen. Into these Triassic strata molten rock (lava) was squeezed up into the earth's outer crust. This cooled and hardened into "trap rock" or diabase which is more resistant and tougher than the red sediments. Consequently, it makes ridges whose surface is often strewn with rounded boulders weathered from the underlying rock. These boulders are seen in the ridge west of Elizabethtown and on Swatara Hill east of Middletown. They have sometimes been mistaken for glacial deposits.

Entering Middletown (population 6,000, elevation 360), the road crosses Swatara Creek, black with coal washings from the anthracite fields many miles to the north. Some of the old houses in the town were built from the local "brownstone" (Triassic sandstone). Especially to be observed are the Frey Mansion on Route 230, built in 1768, and the nearly contemporaneous Saint Peters Church north of the Square. West of Middletown is the U. S. Army Airport. From here to Highspire the route is over a low gravelly terrace which maintains a uniform relief of 30 feet above the Susquehanna River. South of Highspire across the railroad from the highway large gravel pits have been opened. They present an interesting cross-section of the terrace materials.

The Triassic sandstone and shale reappear to the north. Between Highspire and Steelton, Upper Triassic red sandstone, shale, and conglomerate are supposed to be faulted against the Ordovician (Beekmantown) limestone, but the fault is concealed. The Bethlehem Mines Company's flux quarry at the south edge of Steelton shows the folded and faulted and sheared nature of the limestone.

In Steelton (population 13,000, elevation 300 feet), the highway follows the boundary between the Ordovician (Martinsburg) shale hills on the east and the river flood plain on the west, the latter occupied by Bethlehem Steel Company's plant. The shale lies in a closely folded syncline, and Beekmantown limestone again shows on the west side of this syncline between Steelton and Harrisburg as uptilted beds exposed intermittently east of the road. The geology of the region about Harrisburg and north is discussed in detail in this Survey's Bulletin G8, which should be consulted by those desiring further information than is given in the itinerary in the present publication.

Harrisburg (population 80,350, elevation 300 to 400 feet), Capital of Pennsylvania, lies mostly between the Susquehanna River and Paxton Creek on a low ridge of Martinsburg (Ordovician) shale, locally capped by terrace gravel and sand. The higher "hill" section of the city, east of the creek, is also on Martinsburg shale. South Harrisburg occupies the flood plain at the confluence of river and creek. In the great flood of March 1936, Cameron Street, on which Route 230 enters the city, was 8 feet under water at its intersection with Market Street. Front and Second Streets, except in the center of town and a few high sections, were under water for 3 miles northward beyond the city limits.

While in Harrisburg, those interested in the physiography should visit Reservoir Park (elevation 640 feet) in the eastern part of the city. This is a hill supported by a local conglomerate in the Martins-

burg. Here a broad view of the surrounding country is obtained. Hills to the south across the river are composed of Triassic trap and red sediments. To the east and west is the broad Cumberland-Lebanon Valley, its southern half underlain by limestones (similar to those in the Chester and Lancaster Valleys), and the northern half is cut in Martinsburg shale. This shale produces a gently undulating surface at 500 to 550 feet above sea level, long referred to as the Harrisburg peneplane, but now thought to be the result of local leveling. From Reservoir Hill one sees to the north the generally level tops of Kittatinny, Second, and Peters Mountains, rising to 1,300-1,400 feet altitude and supposed to reflect the still older Schooley peneplane. Water gaps, made by the Susquehanna as it maintained the course which it had developed on this higher plane, open before us.

At Harrisburg in the Department of Internal Affairs is the Pennsylvania Topographic and Geologic Survey with offices on the sixth floor of South Office Building No. 1. Information on the geology of the State and references to publications may be obtained by applying at this Bureau.

*Harrisburg-Pittsburgh.* From Harrisburg the tour follows U. S. Route 22 (William Penn Highway) westward along the Susquehanna and Juniata Valleys. The northern end of the City of Harrisburg is largely built upon gravel and sand washed out and spread fan-wise south of the water gap as the river debouched and dropped its load during the melting of the Pleistocene ice sheet to the north. Alluvium and terrace deposits are recognized. Route 22 follows Front Street along the east bank of the Susquehanna River. Facing the stream are some of Harrisburg's finer residences. The broad, shallow, island-dotted river expands on our left. Ahead is the first of the many water gaps which give the Susquehanna a majesty unequalled by any other of our rivers.

This first gap of the Susquehanna River at Rockville, cut through Kittatinny Mountain, has long been a means of access to the interior. Guarded by a block house in the French and Indian War, it became, soon after the Revolution, a gateway for plodding emigrants and their wagons, creeping westward across the mountains. Later came the now-abandoned canal, then the railway. Finally, the highways up both sides mark today the latest exploitation of the gap as a portal to the Alleghenies. Passing the gap, the massive Lower Silurian sandstones which produce the mountain may be observed. At low water, the eroded remnant of these beds makes a ledge which crosses the river and is known locally as "Rockville Dam." Cuts on the Pennsylvania Railroad east of the river display these same rocks in part, but much finer excavations were made available in 1938 through highway construction on the west side. The great scar of this cutting is clearly visible from Route 22. Above it, the crest of the mountain rises to nearly 1,200 feet. Immediately north of Kittatinny Mountain a lesser ridge, Little Mountain, catches the eye. It is composed of vertically up-turned beds of hard, massive Middle Devonian (Hamilton) sandstone, the Montebello. It is exposed in quarries at Rockville on the east side of the river and in abandoned quarries and cuts on the west

side. Rocky ledges mark the course of this sandstone where it crosses the river bed above the Pennsylvania Railroad's main line stone arch bridge. The Upper Silurian and Lower Devonian are lacking here. At the next turn, the road crosses Fishing Creek at the site of the block house which defended the lower Susquehanna and Harris's Ferry during the colonial wars. The alluvial flat at the mouth of Fishing Creek is part of the flood plain of the Susquehanna River above the gap. Bed rock, here concealed on the highway and Upper Devonian in age, is mostly assignable to the Catskill continental facies of red sandstones and shales. Small exposures may be seen in a quarry and on the railroad near Heckton, south of Second Mountain. Looking across the river at this point, we observe that Second Mountain is formed of up-tilted, gray sandstones and conglomerates of the Pocono formation (Mississippian age). They are in sharp contrast to the underlying red Catskill. Incidentally, when these once flat-lying rocks were upended, presumably by a gigantic push from the southeast, the thrust was so strong that the beds were turned over and what were originally their lower surfaces are now uppermost. The Pocono is also a freshwater (continental) formation like the Catskill in a sense, but lacks the red color common to the latter. It carries thin coal beds with numerous remains of plants.

South of the village of Dauphin, the highway passes through the second water gap, that formed by Second Mountain on the east and the south limb of Cove Mountain, opposite, on the west bank of the river. As observed, these ridges are of the heavy Pocono sandstone which dips steeply southward, and forms ledges in the channel. These beds pass underground and rise to the north in Peters Mountain. At Dauphin one may detour up grade northeast of the village onto Red Hill (take hard surfaced road right at the Fire Engine House, State Route 225). The top of this hill is at an elevation of about 500 feet, being 150 feet higher than Dauphin. From this point the sweep of the mountains is particularly impressive. Second Mountain on the south continues in a great arc westward as Cove Mountain which doubles back to the northwest and is prolonged beyond the next water gap in Peters Mountain. These ridges are the limbs of a great, eastward-plunging syncline, the center line marked by Third Mountain, which terminates beside us. Third Mountain is capped by the Pottsville conglomerate. Its white beds may be seen when the leaves are off. This conglomerate carries a little coal and marks the westernmost extension of the Anthracite Fields. The valleys separating Second, Third, Peters and Cove Mountains are underlain by the soft Mauch Chunk red sandstones and shales of middle to late Mississippian age. These beds form a 500-foot surface upon which we now stand. Before us to the north and west, Clark Creek and the Susquehanna River have entrenched themselves into this surface. The third water gap, that in Peters Mountain, lies to the northwest. We shall presently pass through it.

Continuing on Route 22 north from Dauphin, the road crosses a monotonous succession of Mauch Chunk red beds until it threads its way through the gap at Peters Mountain below Clarks Ferry. This is

in many ways similar to the gap at Second Mountain, and, as pointed out, is formed in the same rocks. The ridge rises to 1,200 feet on each side of the river.

As we emerge north from the water gap in Peters Mountain, there lies before us the confluence of the Susquehanna and Juniata Rivers. Where the two converge, a broad flood plain, Haldeman and Duncan "Islands," has developed. Now joined at its north edge to the mainland, Duncan "Island" was severed temporarily and inundated in the flood of March 1936. The highway crosses the Susquehanna on Clarks Ferry Bridge, and then goes up the east bank of the Juniata over the flood plain of Duncan "Island." Stories of pioneer days, Indian raids, the coming of Conestoga wagon trains, canals, railroads and finally automobile highways clothe the place. A memorial to early times is Amity Hall (where U. S. Highways 11 and 22 fork), a famous hostelry in the days of more leisurely travel.

North of Amity Hall a succession of road cuts displays an unsurpassed and practically entire Devonian sequence in descending order from south to north. At first the cuts are in the red continental facies, the Catskill. Though stratigraphically monotonous, they show some splendid structural features, as they have been thrown into a long sequence of nearly symmetrical anticlines and synclines suggestive of the right of way of a roller coaster. Cutting them, one mile beyond Amity Hall, may be seen a 25-foot Triassic dike which is recognized by its rusty color contrasted with the Catskill red and the black rocks immediately adjoining, which were metamorphosed by the heat of the dike. Toward the base of the red beds, marine fossils begin to appear and show that here the rocks are of Chemung age. The great cliff cut for the highway nearly opposite Losh Run (a station on the west side of the river) is in the Trimmers Rock (Portage) sandstone of the Upper Devonian. These flaggy strata are replete with comminuted fossil remains, and contain some unusually fine examples of "storm rollers." North from the cliff, the cuts exemplify to advantage the lower Portage shales, beginning with the Losh Run and passing down through successive representatives of the greenish (here sandy) Brallier, the gray Harrell and the black Burket. All are fossiliferous with distinctive faunules. Finally, at the base of the Burket black shale, limy shales carry Tully fossils and mark the base of the Upper Devonian in this section. The Tully rests directly upon the topmost beds of Hamilton age with characteristic fossils.

The highway next passes low ridges culminating in anticlinal Half Falls Mountain. This mountain and the adjacent upfaulted ridge to the south are supported by the massive Montebello sandstone of Hamilton age. It is the same sandstone that we observed in Little Mountain at Rockville. A short walk up a dirt road at a lime kiln at Half Falls Mountain will repay the observer, for here, in a quarry, the Marcellus black shale rests upon the Onondaga gray limestone. Immediately north of this point the Oriskany sandstone crops out on the highway. It is a pebbly mass with out-weathered casts of large fossil shells. In a gully at the core of the mountain, the topmost beds of the New Scotland (Helderberg) limestone are exposed, though concealed

on the highway. These mark the lowest point, stratigraphically, in this particular sequence, and carry us almost to the base of the Devonian as here used. Those desiring to see the older formations in this region are referred to Bulletin G8. The north limb of Half Falls Mountain anticline is crossed where it is marked by a second exposure of the Oriskany in a roadside cut. The Devonian sequence repeats itself in ascending order from Half Falls Mountain north beyond Newport Bridge, but exposures are relatively poor compared with those between Amity Hall and Half Falls Mountain.

Berry and Buffalo Mountains are Pocono ridges analogous to Second, Cove, and Peters Mountains, but the formation does not come down to river level at this point. The long, flat top of Tuscarora Mountain (Silurian sandstone) forms the northwestern skyline as we approach Millerstown from the south. Continuing through Millerstown and northward, another water gap carries us through the end of Tuscarora Mountain. The hard, light-gray to whitish sandstones and pebble beds are the Tuscarora formation, correlate of the sandstones of Kittatinny Mountain and "Rockville Dam." They have passed far under ground between these two areas.

Millerstown is situated in what was once an iron country. Prior to the opening of the iron mines in the Great Lakes region, the "Clinton" (Silurian) iron ores were extensively mined in Pennsylvania. Millerstown was one of those places fortunately located with relation to this product.

The road after passing the gap above Millerstown follows a lowland underlain by soft Upper Silurian and Lower Devonian strata, many of which are limy. A structurally complicated section in the Onondaga and Hamilton beds is to be seen on the side road north of Thompsontown (State Route 135). At Mexico is a large railroad cut in the Helderberg and older limestones. As the road crosses the flat erosion surface north of Mexico and descends into Mifflintown, we observe to the west along the railroad across the Juniata River, beautifully folded Silurian formations called, because of their concentric arcs, "the Rainbow Rocks." The view east is impressive for the high terrace at road level and the flat-topped mountains. These represent peneplanes or former erosion levels. Mifflintown, county seat of Juniata County (elevation 440 feet), lies at the entrance to Juniata Narrows. The highway passes through another gap in the Silurian formations, and turns sharply west, following the river valley, which is flanked on both sides by high mountains of Silurian strata. Across the river to the south are quarries where silica rock (ganister) is taken in large quantities for making firebrick and other refractories.

Lewistown (population 13,350, elevation 500 feet), is the site of the Viscose Company plant which makes rayon and employes about 5,000 people. Here the road runs west through a valley cut chiefly in Lower and Middle Devonian shales, sandstones and limestones. It is open country and has comparatively little of interest geologically. As we leave this valley at Mount Union, the river and highway cut through Jacks Mountain, a major anticline. Immediately beyond Mount Union, perhaps the finest Silurian section in the State is crossed. Those

interested should walk over the sequence. Starting in the Helderberg limestones at the base of the Devonian, the section cuts across the east limb of the anticline, geographically northwestward, stratigraphically down, through all the known formations of Silurian age recognized in central Pennsylvania, from the Keyser formation at the top through the Tuscarora sandstone (forming Jacks Mountain) at the base. The section actually goes still lower, exposing below the Tuscarora in the center of the up-arched mountain, the red Juniata formation variously assigned to the basal Silurian and highest Ordovician, and the still lower Reedsville shale. This last is of Ordovician age, is fossiliferous, and is approximately the correlative of the Martinsburg shales which underlie the region about Harrisburg. It has passed completely under all of the great mass of Silurian, Devonian and Mississippian formations in the intervening country! The river face of Jacks Mountain has been stripped of its rock floe of Tuscorora sandstone for making silica brick.

Mapleton is famous for its sand quarries. Here the nearly pure Oriskany (Lower Devonian) sandstone beds stand on end. Friable in nature, the rock is readily quarried and then crushed and cleaned for glass sand and other purposes. From these quarries through Huntingdon, another section of Middle and Upper Devonian formations is crossed, but the exposures are relatively poor. The red Catskill shows across the river between Mill Creek and Ardenheim. There, too, is the nose of Terrace Mountain supported by the Pocono sandstone in a narrow syncline. Southward the syncline spreads, forming two mountains—Terrace and Sideling Hill—that enclose the Broad Top Mountain area, an eastern outlier of the Allegheny Plateau. A side trip up Terrace Mountain, via State Route 76, is of geologic interest. The red Mauch Chunk shale above the Pocono includes in Trough Creek Valley the curious Trough Creek limestone. The synclinal valley a-top the mountain is an interesting feature possessed of some unusual drainage aspects. The Raystown Branch of the Juniata which joins the main stream at Ardenheim, has had a complex and surprising physiographic history.

Huntingdon (population 7,550, elevation 640 feet) is the site of Juniata College and of the Pennsylvania Industrial School, a correctional institution for boys. The school is passed just west of the borough. Huntingdon is situated on beds of Middle Devonian age, chiefly, and many fine, fossiliferous localities are within a short walk of the railroad station. Particularly good are those of the Hamilton shales across the Juniata River. The highway from Huntingdon leaves the river and climbs over Warrior Ridge, supported by the Oriskany sandstone, then descends gradually across the Helderberg and Upper Silurian limestones. These may be seen in a long sequence of cuts and at Lincoln Caverns. Of particular interest are the highway cuts along the bank of the Frankstown Branch of the Juniata River at Charlie Hill exposing contorted Middle Silurian shales. The route crosses the Frankstown Branch at Alexandria (elevation 714 feet) and passes a firebrick plant at Alfarata. The ganister used here comes from rock floes of Tuscarora quartzite high on the nearby mountain.

Traversing the gap in Tussey Mountain, we emerge at Water Street. A large quarry along the railroad, south, is in the Bald Eagle sandstone of very late Ordovician age; and the rocks at the west of the road fork are the Bellefonte dolomite.

Proceeding southwest from Water Street (elevation 725 feet), the route penetrates the more open country between Canoe Mountain on the west and Tussey Mountain on the east. Road cuts and quarries expose some very old (Cambro-Ordovician) limestones comparable to those seen between Harrisburg and Philadelphia. Many of these, high in magnesia, are called dolomite. From this limestone valley, the road climbs over a low gap between the north end of Lock Mountain and Canoe Mountain and then around the south end of Canoe Mountain. The rocks forming the two mountains were once continuous. A diagonal fault or vertical break appeared. The two sides slipped past each other and today, with the softer rocks etched out, the hard rocks form two overlapping mountains. The road runs between them. From the road one obtains a good view through the the river gorge where the Frankstown Branch cuts off the nose of Lock Mountain. This is just another example of a stream that maintained its position since it ran on the peneplane independently of the hardness or softness of the underlying rocks.

Northeast from Canoe Creek is a fine section in the Upper and Middle Silurian and Lower Devonian formations. The gently rounded hill along whose axis the road runs between Canoe Creek and Frankstown, is molded in Brallier (Upper Devonian, Portage) olive-green shale. Frankstown is geologically noted because here, years ago, a cave in the Helderberg limestone yielded remains of extinct, backboned animals of the glacial time. They are now on display at the Carnegie Museum, Pittsburgh. Between Frankstown and Hollidaysburg, the road cuts expose the Oriskany and Helderberg groups, the exposure of the Shriver formation and Helderberg groups being one of the best in the State.

Leaving Hollidaysburg (population 6,000, elevation 1,000 feet), we travel westward toward the Allegheny Front. Open flats border the highway through Duncansville, a result of the slow rate of downcutting of the river through Lock Mountain. Helderberg limestone is well exposed in a quarry south of the borough, but Devonian bedrock scarcely shows at all until we begin to rise westward, when outcrops are more frequent. Before us is one of the State's most impressive physiographic features. The Allegheny Front, a bold, terraced wall, extends from Maryland northward in a great arc through central Pennsylvania nearly to the Anthracite Fields. It marks the line where the closely folded rocks of the parallel ridges and valleys of the east stop abruptly and the flat-lying rocks of the high Allegheny Plateau of the west begin. At this point it also divides the Atlantic and Mississippi River drainages. North of this the center-line of uplift passes west of Allegheny Mountain so that all of the headwaters of the West Branch are west of the mountain; and south of this the line passes east of the mountain so that at the south line of the State this divide is several miles east of Allegheny Mountain.

Between Duncansville and Summit, the road rises to 2,320 feet. Cuts display successively from the base the red, uppermost Devonian beds, then the gray Pocono sandstone overlain by the peculiar and strikingly cross-bedded Loyalhanna "limestone." Next we cross the red Mauch Chunk sandstones and shales, and finally, toward the top of the grade, enter the Coal Measures. Along this road is Gallitzin Spring, a famous stopping place since "early days." The summit of the Allegheny Front here is 2,420 feet above sea. The road follows nearly the line of the long-abandoned Portage Railroad. In the days of the canals, the ponderous boats were taken from the water at the foot of the escarpment and hauled by cable railroad to the top. Parts of the old grade and the masonry of one of the bridges with a commemorative tablet attached may be seen along the highway.

Approaching Cresson, one crosses the eastern edge of the great Bituminous Coal Fields, which cover so much of western Pennsylvania. From here west to the Ohio line, road cuts in consolidated rock other than those of the Coal Measures, are comparatively rare. These Coal Measures are of the Pennsylvanian system, the name taken from our State. The relatively flat region of the Allegheny Plateau is broken only by long, low, north-south-trending ridges. The principal ones are Laurel Hill and Chestnut Ridge. These are structural features, for they are due to gentle anticlines which so bulge up the strata that the top of the Devonian system occasionally reaches the surface. Laurel Hill is crossed a little beyond Mundys Corners, eight miles west of Ebensburg (population 3,075). Its relief, which is very slight at this point, may be noted from observing that Ebensburg lies at 2,300 feet, and the highway attains an elevation of nearly 2,500 feet at the ridge crest. The second anticline, Chestnut Ridge, is crossed in Indiana County east of Blairsville. The road climbs to a maximum elevation of just under 1,900 feet, and then drops to only 900 in crossing the Conemaugh River at Blairsville.

In addition to Laurel Hill and Chestnut Ridge anticlines which are major features of the plateau structure, there are many minor anticlines and synclines. The Coal Measures which underlie nearly all of the area from Cresson to the western State line consist from the bottom up of: Pottsville sandstone 180 feet with a little coal in the middle; the Allegheny formation or "Lower Productive Coal Measures" 300 feet thick, with from 7 to 12 coal beds of which seven are widely workable—the Brookville, Clarion, Lower, Middle, and Upper Kittatinny and Lower and Upper Freeport. Above that is the Conemaugh group or "Lower Barren Coal Measures," 900 feet thick at Cresson, but only 630 feet thick at Pittsburgh. They contain over 75 named beds of shale, sandstone, coal, clay, and limestone, hardly any of which have more than local value. Then comes the Monongahela or "Upper Productive Coal Measures" with the Pittsburgh coal at its base, the Uniontown and Sewickly coals above and the Waynesburg coal at the top. Still above these in the southwest corner of the State, but not along this route, is the Dunkard series or "Upper Barren Coal Measures," 1,100 feet or more thick and of Permian age.

At the crest of Allegheny Mountain only the basal members are present. At Blairs Gap, east of Summit, the base of the Conemaugh is just caught and the Allegheny coals are below and dipping westward so rapidly that the Upper Freeport coal which is 2,300 feet above sea level on the east side of Blairs Gap is down to 1,300 feet above sea level in the Wilmore syncline where the road crosses the North Branch of Conemaugh River just west of Munster, or 400 feet below the creek valley. From there the beds rise rapidly toward Ebensburg and on the Ebensburg anticline just west of town the Upper Freeport coal is up to 1,900 feet A.T., or only 100 feet below the surface.

From Ebensburg to Mundys Corners, the coal beds and other strata dip steeper than the surface so that at Mundy Corners the Upper Freeport coal is 450 feet below the surface in the Johnstown syncline. From there the strata climb rapidly up toward Laurel Ridge. The Upper Freeport coal crops out on the road just east of the crossing of Hinckston Run and the other coal beds crop out between there and Chickaree where the basal Brookville coal appears, and the road passes onto the Pottsville sandstone. It continues in Pottsville rocks with some showing of the underlying Mauch Chunk down the west slope for almost two miles until the steep westward dip brings the Allegheny or Lower Productive Coal Measures down to the surface forming a narrow belt, and the road passes onto the Conemaugh strata with the Allegheny formation and its coals below the surface. They continue below the surface to a point several miles west of Clyde, where they rise to the surface over Chestnut Ridge anticline which in this area has become very low as compared with the same anticline farther south. At Black Lick the Lower Productive Measures pass below the surface and do not reappear farther west on this route in Pennsylvania.

Reverting to the route farther east, it should be observed that at Mundys Corners (elevation 1,897 feet) one may turn south on U. S. Route 219 for 11 miles to Johnstown and follow the 1,200-foot deep gorge of Conemaugh River through Laurel Ridge. The succession of rocks beginning at Johnstown is downward from Conemaugh beds through Allegheny and Pottsville of the Pennsylvanian system, then the Mauch Chunk, Loyalhanna and Pocono of the Mississippian, and finally, the highest beds of the Devonian system. The rocks and structures are all well exposed, particularly when the leaves are off. For best understanding of this section, it is suggested that State Route 403 on the north side of the river be followed.

West of Mundys Corners, on the top of Laurel Hill (elevation 2,480 feet), the surface is strewn with blocks of Pottsville and lower Allegheny sandstones. Down the west slope the road crosses red and green Mauch Chunk sandstone and shale, and, descending farther, passes in succession over the westward-dipping outcrops of Pottsville, Allegheny and Conemaugh beds. The broad view to the west from this high ridge is of a dissected plateau with Chestnut Ridge rising above it.

At Blairsville (population 5,300, elevation 1,000 feet above tide), the road passes over the first of a series of northeast-southwest basins that bring the Pittsburgh coal down into the hilltops or below the road.

At Blairsville coal occurs only in the hilltops on both sides of the river. This is the northern end of the Latrobe coal basin. West of Blairsville, the exposures are all in the Pennsylvanian. A little west of New Alexandria, the Pittsburgh beds again descend to and below the road in the northern part of the Greensburg basin and between Delmont and Export the Pittsburgh bed in the Irwin basin is again below the surface. Several mines are seen in this district exploiting the Pittsburgh bed. At Murraysville are many gas wells. As the road crosses Turtle Creek and continues west to Pittsburgh, it is in outcrops of the Conemaugh formation with the Pittsburgh bed underlying the tops of all the hills, including those in the City of Pittsburgh itself. Some of the deep road cuts show other coal beds as well.

In entering Wilkinsburg the road descends from hills at 1,200 feet or more A.T. to a broad, flat valley at 900 feet A.T. This valley is an abandoned channel of the Monongahela River now standing 200 feet above the present river level. It dates from before the last ice advance at a time when the drainage of all this region flowed north to what is now Lake Erie, then only a major valley. The coming of the ice blocked the outlet and the drainage found a new outlet down what is now the Ohio, in consequence of which the channels were lowered to their present level. Before the new outlet had been well established, the waters were ponded in front of the ice, the old valleys filled to a high level with sediments so that when downcutting began again the new river made many short cuts, leaving oxbows of its old course high and dry. This last lowering of the valleys to the present level appears to have been quite rapid, which accounts for the narrowness of the present lower valleys and the lack of broad bottom lands around Pittsburgh.

Pittsburgh (population 669,825), city of steel mills, where Carnegie Institute of Technology, the University of Pittsburgh, with its notable Cathedral of Learning, the Carnegie Museum, the Mellon Institute, and more are passed as we cross the city. We presently follow the Boulevard of the Allies, dropping gradually from 1,200 feet in the vicinity of Wilkinsburg to about 700 at the confluence of the Allegheny and Monongahela Rivers. Soon, as the route turns south across the Monongahela, one may see to the west the confluence and the beginning of the Ohio River proper. Across the Monongahela from Pittsburgh, a pause just beyond the funicular railway allows a view of a great cut in Pennsylvanian formations. This is a splendid opportunity to form an appreciation of the character of the rocks associated with the coals immediately beneath the surface of western Pennsylvania. Rising again from the river and Chartiers Creek, we come to oil derricks and pumps in the Florence oil pool. (See Bulletin G 17.)

The road from Pittsburgh west to the Ohio line presents comparatively little requiring special comment. Important exposures are noted in the schedule. As immediately to the east of Pittsburgh, the geologic sequence is entirely in the Pennsylvanian formations. Here, however, occasional limestone is to be observed, a feature not seen to the east on Route 22. Both fresh-water and marine limestones are known, and

some of these are of considerable correlative value. Crossing the West Virginia-Pennsylvania State Line, east of Paris, at 1,100 feet, the road descends to the Ohio River and crosses that stream to Steubenville, Ohio.

## DETAILED ITINERARY

The following detailed itinerary is intended to call attention to the important rock exposures and other points of geologic interest between Philadelphia and Pittsburgh *via* Harrisburg. Approximate mileages are given from or to the zero mile post behind the State Capitol at Harrisburg. The map, Plate 17, shows the route followed, but it is well to supplement this with a road map, such as that published officially by the Pennsylvania Department of Highways. In the following itinerary, bold-face numbers are west-bound mileage, light-face are east-bound between Philadelphia and Harrisburg.

| | | |
|---|---|---|
| **Philadelphia.** | **99**<br>**0** | See introductory remarks to this bulletin on the local geology within the city limits and alternate routes out of Philadelphia until reaching the Lincoln Highway at the city line. Stations which follow begin on the Lincoln Highway (U. S. Route 30) west of the city limits of Philadelphia. Distance **0** is City Hall. Bold-face numbers are miles from City Hall; light-face numbers are miles from Harrisburg. |
| 1. | 88<br>**11** | East side of Berwyn. Cuts expose the Wissahickon gneiss. |
| 2. | 80<br>**19** | East of Malvern. The old road passes through the town; the new cut-off bears right under the railroad and across a low ridge of crystalline rocks. Cuts at the intersection of the old and new roads and beyond across the crest of the ridge expose the Wissahickon gneiss or schist which may be quartzitic locally. |
| 3. | 69-75<br>**24-30** | Along the highway east of Downingtown an occasional small cut exposes the Cambro-Ordovician limestones standing nearly perpendicular. It is these rocks that floor the Chester Valley. |
| 4. | 68.8<br>**30.2** | West edge of Downingtown. Across the railroad south of the highway, excavations expose the Conestoga limestone. |
| 5. | 54.5-62<br>**37-44.5** | West edge of Coatesville after crossing the railroad; a large cut exposes the Harpers schist. Continuing west the road crosses Mine Ridge. As it runs along the crest, the light-colored Cambrian quartzites are to be seen in outcrops and quarries to the north and are exposed in cuts about 2 miles east of the town of Gap. |
| 6. | 51<br>**48** | Gap. See introductory remarks for statements on the abandoned nickel mine near here (page 5). |
| 7. | 50<br>**49** | West edge of Kinzers. A sizeable quarry north of the highway is operating in the Vintage dolomite of Cambrian age. |
| 8. | 46.7<br>**52.3** | After passing through Paradise and crossing Pequea Creek, the road climbs upgrade. To the south are ledges and an abandoned quarry in the Conestoga limestone. No geological features of interest are to be seen until after leaving Lancaster by way of U. S. Route 230. |

9. 35.2 **63.8** North of Lancaster at curve in road, cuts on both sides expose bedrock. To the southeast sheared, sandy shale dips southeast; to the northwest, thin-bedded limestone dips northwest. The two are faulted together, but probably both are parts of the Kinzers formation.

10. 28-30 **69-71** Northwest of Salunga the highway has recently been relocated, opening fresh cuts. Particularly, these are to be observed near the underpass beneath the railroad. The cuts expose the Beekmantown dolomitic limestone with its capping of residual soil.

11. 21 **78** Northwest of Florin to a point approximately opposite Rheems along new highway cuts, the Ordovician (Beekmantown) limestone or dolomite is exposed in several cuts. Note the deep, residual, red soil overlying the limestone. Locally, also, are masses of milky quartz which may have been derived from the breaking up of the now eroded Cocalico shale.

12. 19.6 **79.4** South of Elizabethtown, the newly relocated highway exposes several rock cuts. These are in non-red Triassic sediments (New Oxford formation) and are chiefly friable, light-brown sandstone and brown shale.

13. 16.8-18 **81-82.2** After passing through Elizabethtown, the road climbs over a ridge of Triassic igneous rocks. At the crest numerous boulders of these dark rocks strew the surface and have been mistaken for a glacial deposit. They are produced by the breaking up along joints (cracks) of the underlying rock.

14. 14-16.7 **82.3-85** The valley of Conewago Creek is in a low belt of Triassic red sediments which sparingly show along the road.

15. 12-14 **85-87** The road next climbs over Swatara Hill. Near the crest on the southeast side, cuts expose gray rock which is Triassic sediment baked by contact with nearby igneous intrusions. Once these sediments probably were red, but the "cooking" changed the color. Igneous boulders are plentiful at the hill top; and, when we drop down to the foot, going northwest, the unaltered, red sediments again appear.

16. 11.2 **87.8** Swatara Creek is crossed east of Middletown. The black water owes its color to the presence of finely powdered anthracite washed down from the fields scores of miles distant.

17. 7.8-9.8 **89.2-91.2** No exposures are had through Middletown. From that borough, the road to Highspire traverses a flat river flood plain or gravel terrace. At the south edge of Highspire to the west across the railroad and nearer the highway are several gravel pits in which exposures of the old flood plain sediments are excellent.

18. 5.3 **93.7** Between Highspire and Steelton cuts along the east side of the highway expose abundantly the Upper Triassic (Gettysburg) red sandstone, shale and conglomerate. These beds are presumed to be faulted down against the Ordovician limestones to the north, but the contact is hidden.

19. 4.7 **94.3** South edge of Steelton. East of the road the Bethlehem Mines Corporation has opened a large quarry in the Beekmantown limestone. The rock is well exposed, and its distorted nature may be readily appreciated from a glance at the quarry wall which faces the highway.

20. 0-4 **95-99** Steelton to Harrisburg. Several cuts and abandoned quarries east of the highway expose the Beekmantown limestone. Noting the variation in the attitude of these rocks, one appreciates to what extent they have been compressed and folded. Exposures are wanting in the south and central parts of Harrisburg. The local geology is described in this Survey's Bulletin G8. See also the introduction to the present Bulletin. From Harrisburg, the tour continues north and west on U. S. Route 22. The data for the following stations through number 45 are taken from Bulletin G8.

21. 0-4 **272** Starting at the zero mile post* behind the State capitol at Harrisburg, follow Route 22 north from the city along Front Street. The northern end of Harrisburg is built upon river gravel and sand deposits similar to those seen near Highspire.

22. 4.4 **267.6** View of Susquehanna Gap in Kittatinny (Blue, First or North) Mountain. On the slope east of the gap about half way to the top are patches of Tuscarora gray sandstone and conglomerate. These carry *Arthrophycus*. Note that, not the Lower Silurian gray sandstone, but the Middle Silurian red sandstone forms the mountain crest. Across the river is seen Little Mountain, its face scarred by a large, abandoned quarry. Little Mountain is supported by Middle Devonian sandstone. The uppermost Silurian and Lower Devonian are probably faulted out or were never deposited in this region.

23. 5 **267** The Tuscarora sandstone forms "Rockville Dam," a ledge crossing the river and exposed at low water.

24. 5 4 **266.6** Rockville. Those wishing to visit the section here should walk east on the first street north of the railroad bridge. The Silurian formations are well exposed along the railroad and on the north slope of Kittatinny Mountain. Along the end of Little Mountain, a series of quarries exposes the Middle Devonian Montebello sandstone. It is quite fossiliferous, and collecting is good. In the first (southernmost) quarry the black Marcellus shale shows, and across the valley to the south are the red shales of the Middle Silurian. No Lower Devonian has been recognized in place here.

25. 6.1 **265.9** Crossing Fishing Creek. The stream occupies an Upper Devonian shale valley, mostly belonging to the red Catskill facies.

26. 6.7 **265.3** Hecks Station (Heckton). Across the railroad to the east is an abandoned stone quarry in the Catskill red and green sandstones and shales which carry plant fragments. These are interbedded with red strata to be seen north and south of here.

27. 8.9 **263.1** The Catskill-Pocono contact is exposed on the railroad above the highway.

28. 7.2 **264.8** Large, walled-up spring at east of road. On climbing the railroad embankment here, a fine section of the lower part of the Pocono is to be seen in cuts. This is in the Second Mountain member (see Bulletin G8). It and the higher beds of the Pocono may be viewed across the river where they form the south limb of Cove Mountain syncline. The limb is overturned, so that the base of each bed is above its top.

29. 8.0 **264.0** Crossing Stony Creek. The Mauch Chunk red shale and sandstone of Mississippian age crop out along the banks of the stream. Contact with the Pocono to the south is hidden.

* Light-face numbers indicate miles west from Harrisburg; bold-face, east from Steubenville, Ohio.

30. 8.1 **263.9** Dauphin. A side trip along Route 225 (north) may profitably be made here. About a mile from the highway intersection, stop at the brick school house. The rock under foot is the Mauch Chunk, dominantly red beds. The crest of Third Mountain northeast of the school is the western extremity of the basal Pennsylvanian system, the Pottsville conglomerate of the Anthracite Fields. It is here exposed in an overturned syncline above the red beds. When the leaves are off, the white rock shows at the mountain crest. The physiography here is spectacular. Cove Mountain swings around to the west uniting Second and Peters mountains in a great bow. The even crests of these ridges may be seen. The school stands upon a lower level into which Clark Creek has entrenched itself. Water gaps of the Susquehanna River are conspicuous features. The route should be retraced to Dauphin, and thence north.

31. 10.9 **261.1** Cuts here and for about 3 miles show the Mauch Chunk red beds. (Road relocated to west in 1939.)

32. 13.7 **258.3** Speeceville. To the left across the railroad at the foot of the grade (Red Hill) are abandoned brick works which used river clays. At the right is a zone of calcareous nodules in the Mauch Chunk shales.

33. 14.6 **257.4** Underpass. Massive Pocono (Mississippian) beds show in road cuts and along the railroad. This formation carries coal beds up to four feet thick, but of very poor quality. They have been mined locally.

34. 14.7 **257.3** Across the river the Pocono is exposed in the face of Cove Mountain. South of Duncannon the Catskill forms Pine Ridge.

35. 16.7 **255.3** This part of the Catskill is the hard, gray Honesdale sandstone and adjacent beds. At Clarks Ferry turn left across the Susquehanna River to its confluence with the Juniata (16.2 miles). West end of Clarks Ferry bridge. Bear right, as Route 22 crosses Duncan "Island" up the east bank of the Juniata. The "island" is a floodplain developed at the confluence of the two rivers. It was flooded in 1936. Across the Juniata to the west the folded Catskill red beds show in railroad cuts.

36. 18.4 **253.6** Amity Hall. Bear left on Route 22 at the intersection. The Catskill red facies of the Devonian is abundanly exposed in road cuts. The occasional thick, green lenses are probably in part channel deposits and often include macerated plant fragments. In the lower part of the Catskill are thin greenish shales which may carry marine fossils belonging to the Chemung formation. These are the only marine Chemung recognized in this area, except for a few recurrent faunules higher in the Catskill.

37. 19.5 **252.5** Cut, east of road, north of small gully. The vertical, yellowish to rusty band, 20 to 30 feet wide, in the midst of the red beds is a sill or dike of Triassic "trap". The adjacent sediments have been baked gray.

38. 20.2 **251.8** Road cuts expose chocolate-colored beds underlying the base of the Catskill. These are assigned to the Parkhead, uppermost member of the Portage group in Maryland.

39. 20.5 **251.5** High rock cut along the road. The cliff is Trimmers Rock (Portage) sandstone with Ithaca fossils. Storm rollers and fossiliferous bands may be observed.

40. 20.8-21
**251-251.2**

Starting from the south end of a series of cuts from the first gully north of 39, the lower Portage shales are completely exposed. At the north side of the gully, the first beds seen are the Losh Run shale with abundant examples of *Reticularia laevis* and other fossils. Immediately below the Losh Run shale is a section of the most contorted Devonian known in central Pennsylvania. It consists of folded and crushed greenish shales and sandstones, the eastward equivalent of the Brallier shale of more western sections (see 88). Descending still farther toward the north, the dark gray Harrell shale (here quite sandy) is encountered. It carries a Naples fauna. The Harrell is underlain by about 200 feet of black, fissile shale called the Burket ("Genesee" of earlier writers). With careful search in these beds a few very small fossils are to be found. At the base of the Burket about 10 feet south of the next gully east from the river, the Tully shale and limy beds show with characteristic fauna. They rest directly upon the top of the Hamilton shale with its typical fossils.

41. 21.1
**250.9**

Crossing Hamilton sandstones and shales. These are the same beds as were seen in Little Mountain, though less sandy. The sandstone supports Half Falls Mountain and other ridges in Perry County.

42. 21.4
**250.6**

The valley to the east is in downfolded Burket and upper Hamilton shales.

43. 21.8
**250.2**

East of the road, the large talus slope is composed of blocks of the Montebello sandstone. It marks a fault scarp.

44. 22.2
**249.8**

Immediately south of a limekiln, a short side trip on foot up a secondary road north may be made. Ascending this road, we presently reach a quarry in the Onondaga (Selinsgrove) limestone overlain by the black Marcellus shale. These beds are in the south side of Half Falls Mountain which is an anticline supported, as observed, by the still higher Montebello sandstone. Descending through the woods or returning to the road and walking north, the outcrop of the Oriskany sandstone is seen. It is coarse, pebbly material with the casts of weathered-out fossils. It dips south and lies below the limestone seen in the quarry, but passes up (north) above another limestone (the Helderberg) to be seen in a small gully east of the road at the axis of the mountain. The second limestone is the lowest Devonian observable in this section, and it is assigned to the New Scotland formation.

45. 22.4
**249.6**

Continuing north on Route 22, a second exposure of the Oriskany marks the north limb of Half Falls Mountain syncline.

46. 22.9
**249.1**

Board Run; Middle Devonian, Hamilton, dark shale is exposed in the brook bed east of the highway and is fossiliferous.

47. 23.4
**248.6**

A small, abandoned quarry east of the road is in Burket ("Genesee") black, fissile shale.

48. 23.5
**248.5**

Opposite Bailey. The Trimmers Rock sandstone comes down again to highway level.

49. 24.5
**247.5**

Continuous exposures for the next two miles follow a great bend in the Juniata River. The rocks are the Catskill continental facies such as was observed to the south above Amity Hall.

| | | |
|---|---|---|
| 50. | 26 plus<br>**246 and under** | Southeast from Newport bridge, the Upper Devonian sandstones and shales of the Portage group are exposed in extensive road cuts through a hill. High river gravels are to be seen at the top of the cut banks. Immediately south of Newport bridge, additional cuts expose more of the fossiliferous Portage strata. Also, the Portage-Catskill interfingering can be here seen with no recognizable Chemung faunule. |
| 51. | 28<br>**244** | Commencing at Newport bridge and running north, many cuts for about 2 miles expose the Catskill continental beds on the east side of the Juniata River. These beds are in the south limb of the Berry Mountain syncline. |
| 52. | 30 5<br>**241.5** | Axis of Berry Mountain syncline. Great cuts again show the Catskill beds. The rather massive, greenish sandstone is probably the Honesdale, a member of the Catskill, but this correlation is not proved. |
| 53. | 33 plus<br>**239** | South of Millerstown at the south bank of Cocolamus Creek, cuts east of the highway expose the Portage shales. Passing north through Millerstown, the Upper Silurian (Wills Creek) shale is to be seen in a small, abandoned quarry east of the road. The intervening strata are concealed through the town, but partly exposed west, across the river, chiefly in road and railroad cuts. |
| 54. | 35<br>**237 and under** | Axis of Tuscarora Mountain. The Lower Silurian, Tuscarora, sandstone and conglomerate are exposed in cuts east of the highway. The formation is here uparched in an anticline. Iron-bearing, Silurian sandstones are common in this region and were once exploited. |
| 55. | 36.5<br>**235.5** | Skirting Slaughterback Hill, Upper Silurian shales crop out. |
| 56. | 38-44<br>**228-234** | Through Thompsontown and Mexico, the road follows a lowland cut in the Upper Silurian and Lower Devonian formations, and outcrops are practically nil, until Mexico is reached. At this town, the Helderberg limestone shows in railroad cuts across the river; sandstones in the Marcellus crop out in Turkey Ridge. In this region we have also the anomalous condition of the Siluro-Devonian limestones forming low ridges, while the overlying Oriskany sandstone fails often to produce any noticeable topographic expression. |
| 57. | 47<br>**225** | South of Mifflintown, small road cuts show the red Bloomsburg shale. The view east is impressive with peneplaned surfaces and flat-topped ridges. |
| 58. | 48<br>**224** | Looking west from the brow of the hill south of Mifflintown, across the river, one sees in railroad cuts the so-called "rainbow rocks", a series of beautifully arched Silurian strata. These are seen even better from the highway as it curves down grade into Mifflintown. |
| 59. | 48.9<br>**223.1** | North from Mifflintown, new highway construction has recently furnished some splendid cuts in the Silurian formations. These commence to the south in the Bloomsburg red beds and continue in descending order through intermittent exposures for about 2 miles. Among the beds is the relatively heavy, gray Keefer sandstone, brought up in an anticline and shown in a cut along the east side of the road. |
| 60. | 53<br>**219** | At this point the road enters the Juniata Narrows. The highway has recently been relocated so that it is in part built upon the line of the old canal. Many cuts for about 5 miles expose beds of the Silurian system. |

61. 54.6 **217.4** Cuts in heavy talus overlying Silurian shales. An abandoned quarry north of the road is in Middle Silurian shale, and above it the heavy talus descends from outcrops of the Tuscarora sandstone. The structures here are rather involved.

62. 56.4 **215.6** Across the river, south, is a silica brick plant which uses the Lower Silurian white to light-gray or buff Tuscarora sandstone, locally a true quartzite. It is nearly pure silica and forms the ridge behind the plant. This is the same rock that makes the blocks in the great talus slopes along the Narrows. North of the road in cuts may be seen vertical beds of the Lower Silurian.

63. 56.7 **215.3** Cuts and quarries expose more Silurian strata beneath additional talus slopes of Tuscarora sandstone.

64. 57 **215** Silurian sandstone, probably the Keefer, shows in cuts along the road. Additional talus slopes follow to the west.

65. 58.5-59 **213-213.5** Leaving the Juniata Narrows, the route runs north through Lewistown. Intermittent exposures are passed along the highway. They are chiefly in cuts in the Middle and Upper Silurian, but no red beds of the Bloomsburg facies are seen. From Lewistown, the route continues west along an open stretch of country underlain by relatively soft, or soluble, Upper Silurian and Lower to Middle Devonian strata.

66. 66 plus **206 and under** Cuts in the Upper Silurian and Lower Devonian limestones. To the north of the highway the Oriskany sandstone forms a low ridge parallel to the road. Occasional quarries in the ridge expose the sandstone which is worked for various purposes.

67. 70 **202** Passing through McVeytown, the road runs on west. Cuts show the Tonoloway "ribbon" limestone at intervals for half a mile or more.

68. 71.9 **200.1** At this point a prominent cut shows an interesting succession. From east to west the sequence is: Oriskany sandstone (Lower Devonian), Onondaga black shale and shaly limestone (Middle Devonian). The Onondaga is usually a limestone, but in this region, particularly about Newton Hamilton, it is dominated by a thick, black shale member of local distribution only. The limy beds tend to weather to an olive-drab, punky residue.

69. 72.1 **199.9** Black shales are well exposed in cuts. These would ordinarily be assigned to the Marcellus, but are partly Onondaga in age as observed at station 68.

70. 74-75 **197-198** The highway crosses a low ridge formed by the Oriskany sandstone which may be seen in a cut at the top. Continuing down grade to the west, cuts south of the road expose the Helderberg limestones. These same beds reappear at intervals for over a mile west.

71. 78.1 **193.9** Cuts expose the Upper Silurian limy shale and limestone, which may be quite shaly. Some of the rock is marked on the bedding by polygonal cracks. When these sediments were soft mud, they dried and cracked, perhaps at low tide, and these ancient cracks are preserved today to tell their story. The section carries the tour past the junction with the road south to Newton Hamilton.

72. 81 **191** From this point we cross what is perhaps the finest Silurian section in the State of Pennsylvania. It has been studied and the details published by Dr. F. M. Swartz. His section is abstracted, with slight changes in terminology based upon subsequent work, as follows:

LOWER DEVONIAN

Oriskany group
Helderberg group
New Scotland limestone
Coeymans limestone

SILURIAN

Cayugan series
Keyser limestone
Tonoloway limestone
Wills Creek shale
Bloomsburg red shale
Niagaran series
McKenzie shale and limestone
Clinton group
Rochester shale
Keefer sandstone
Rose Hill shale
Medinan series
Castanea sandstone
Tuscarora sandstone

UPPER ORDOVICIAN

Juniata red shale and sandstone
Bald Eagle sandstone
Martinsburg (Reedsville) shale

Swarts says of this section (Geol. Soc. Am. Bull., vol. 45, 1934, p. 83): "Parts of all the local Silurian formations are exposed in the south-eastern limb of Jacks Mountain anticline, on the north bank of the Juniata River. The base of the section is 1,115 feet west of the bridge crossing the river to Mount Union . . ."

DEVONIAN

| Helderberg group | *Feet* |
|---|---|
| New Scotland limestone, thin-bedded, gray limestone with much interbedded dark chert above. Thick-bedded gray, crystalline limestone with chert, below. Top concealed | 16 |
| Coeymans limestone, thick-bedded, grayish, somewhat crinoidal limestone. Partly concealed, contacts hidden | 10 |

SILURIAN

| | |
|---|---|
| Keyser limestone, hard, dense, laminated blue limestone above, thick-bedded, hard, non-lumpy, dense limestone in middle, thick-bedded, partly lumpy limestone in lower part | 160 |
| Tonoloway limestone, hard, dense, largely laminated, blue limestone, but varies somewhat in lithology at intervals | 820 |
| Wills Creek shale, thin-bedded, limy shale and argillaceous limestone, etc. | 460 |
| Bloomsburg red shale, interbedded red and green shale | 155 |
| McKenzie shale and limestone | |
| Upper gray shale and limestone member | 355 |
| Rabble Run red bed member | 385 |
| Lower gray shale and limestone member | 215 |
| Clinton group | |
| Rochester shale, partly concealed, thin-bedded, gray to greenish shale. | 40 |
| Keefer sandstone, interbedded limy sandstone and greenish, sandy shale, etc. | 47 |
| Rose Hill shale, green, somewhat sandy shale, oölitic hematite and thin limestone beds | 727 |
| Castanea sandstone, medium to thin-bedded, greenish sandstone. Top separated from the Rose Hill by 115 feet concealed | 58 |
| Tuscarora sandstone, thick-bedded, partly cross-bedded, hard, white sandstones, lower part hidden | 210 |

73. 83.2-87.2 **184.8-188.8** Continuing below Swartz's section at 72. Beneath the lower Silurian is seen the Juniata red sandstone and shale in cuts east of the road. The Upper Ordovician gray Bald Eagle sandstone rises in the axis of Jacks Mountain anticline.

74. 87.3 **184.7** At this point the Reedsville shale (approximately equal to the Martinsburg noted to the south) is poorly exposed among bushes along the right of way.

75. 88.3 **183.7** Opposite Mapleton, large quarry in the Helderberg limestone. Its relation to the beds at 76 is interesting.

76. 88.4 **183.6** The renowned Mapleton glass sand quarries open along the highway at this station. They are in the Lower Devonian, Oriskany, sandstone, whose massive strata are tipped up approximately on edge. The rock is crushed and used for glass sand and other purposes.

77. 91-92 **180-181** The highway is now crossing a down-warp of the beds which brings the Catskill red strata to road level. This is the Trough Creek syncline. Fossiliferous Upper Devonian shales and sandstones, the Chemung, are exposed in road cuts beneath the Catskill red beds. It will be recalled that north of Amity Hall very little Chemung was to be seen (cf. 36). There, the red beds begin at the close of the Portage.

78. 94.8 **177.2** South of Huntingdon, railroad cuts in the Upper Devonian, east of the road, give an unusually good sequence in the Brallier greenish shale.

79. 96 plus **176 and under** Concealed through Huntingdon, the Devonian again is encountered at the Industrial School north of the borough. Small cuts and gutter exposures are in the Marcellus black shale with occasional thin limestone beds or nodular layers which are fossiliferous. Ascending Warrior Ridge, the road is cut at several places into beds of Oriskany (Ridgeley) sandstone.

80. 100 **172** Beyond the Oriskany as we begin to drop down the west side of Warrior Ridge, the Lower Devonian and Upper Silurian limestones are abundantly displayed in many cuts on the highway which was relocated a few years ago. Some of the limestone is cavernous, as illustrated in the "Lincoln Caverns" on this road.

81. 101.9 **170.1** Charlie Hill. Cuts expose the Wills Creek and probably older Silurian strata, much distorted, reminding one of the beds in the "rainbow rock" south of Mifflintown at 58.

82. 104 **168** Passing through Alexandria, note the broad, flat, river flood plain about the town.

83. 105.4 **166.4** Northeast of the road is a silica brick plant. The silica is obtained from high on the adjoining ridge.

84. 105.8 **166.2** Gap east of Water Street. The Juniata red sandstone shows in cuts east of the road. Above, in the ridges, the Tuscarora white sandstone forms talus slopes, a great conical mass of which is observed across the river.

85. 106 **166** Water Street. Upper Ordovician, Bald Eagle sandstone is here seen, and the Bellefonte dolomite of Middle Ordovician age appears still farther along.

86. 111 **161** West edge of Shaffersville, cuts south of road expose the Lower Ordovician, Nittany limestone. Other exposures are to be seen westward for about a mile.

87. 112-118
**154-160**
The Bellefonte dolomite is again encountered; note its deep, residual soil. This formation shows intermittently to the edge of Yellow Spring village. Leaving the Ordovician, we are now rising in section, and here is exposed some of the red shale of the Bloomsburg continental beds of the Silurian. Exposures of the Silurian are encountered in a long section down grade, continuous most of the two miles into Canoe Creek village.

88. 118
**154**
West of Canoe Creek. The Upper Devonian, Portage shale called the Brallier, greenish, fissile, and other Upper Devonian units are exposed in cuts for over a mile. At their western end the gray Harrel shale is fossiliferous. Compare with the sandy character of these beds on the Juniata at station 40.

89. 122
**150**
Entering Frankstown, and then to Hollidaysburg, cuts expose the Lower Devonian formations. West of Hollidaysburg, the beds are largely concealed to the base of the Allegheny Front. This scarp rises before us as we continue west through Duncansville.

90. 132
**140**
Approaching the Allegheny Front and starting up grade, the Catskill red beds of the Devonian are exposed at the reservoir.

91. 134.2
**137.8**
At the south side of the road, below highway level, Gallitzin Spring is situated. Cuts expose the Lower Mississippian, Pocono sandstone, all very massive.

92. 134.4
**137.6**
Continuing up the "Front," the Middle Mississippian is crossed, marked by the strongly cross-bedded Loyalhanna sandy limestone or sandstone.

93. 142.2-143
**129.8-129**
West edge of Munster. Cut. The Upper Pennsylvanian, freshwater formed, Conemaugh sandstone and shale with thin coal crops out.

94. 143.5
**128.5**
Cut exposes the Upper Pennsylvanian, Conemaugh sandstone. A thin coal bed also shows with underlying fireclay.

95. 147.5
**124.5**
Ridge east of Ebensburg. Upper Pennsylvanian sandstone and shale of the Conemaugh are exposed.

96. 148.4
**123.6**
At the east boundary of Jackson township a cut exposes Conemaugh shale with some small, ovoid concretions.

97. 149.2
**122.8**
Conemaugh heavy sandstones and interbedded shales are exposed here.

98. 151
**121**
Mundys Corner. Road cuts newly expose part of the Allegheny formation. At this point those interested may detour south to Johnstown and visit the gorge of the Conemaugh River. For remarks on this side trip, see the introduction to this Bulletin.

99. 152.4
**119.6**
Chickaree. Extensive cuts expose beds of the Allegheny formation. This consists of shales and sandstones and thin coals. East of the filling station at the northeast corner of the crossroads, vertical jointing shows in the shales, and immediately east thereof (at a row of mail boxes) is a small fault where the beds have broken and slipped over one another. Faulting is rarely seen in this region.

100. 153.3
**118.7**
North of the highway is an abandoned stone quarry in the Pottsville sandstone. These heavy beds mark the base of the Coal Measures and form much of the cap rock of Laurel Hill at the crest of which we now find ourselves. Note here the relatively flat top of this ridge up which we have just climbed and down the west slope of which we are about to continue.

| | | |
|---|---|---|
| 101. | 154.9<br>**117.1** | From this point a view is obtained of Laurel Hill. Note the flat tops of the hills and the deeply cut valleys. The higher surfaces are remnants of a peneplain which was long ago uplifted and dissected by the streams. The Conemaugh River west of Johnstown (south of here) has cut a gorge through the ridge. |
| 102. | 156.5<br>**115.5** | Cuts and a small abandoned quarry expose again the Upper Pennsylvanian strata. The float rock here is probably from the Pottsville. |
| 103. | 157.4<br>**114.6** | Conemaugh shale is exposed. |
| 104. | 169.5<br>**102.5** | Upper Pennsylvanian, Allegheny, heavy sandstone float rock is common. |
| 105. | 172 plus<br>**100 or under** | Crossing Chestnut Ridge. This is another anticlinal ridge similar to Laurel Hill which we recently traversed (see Introduction). At the top the Lower Pennsylvanian, Pottsville sandstone float is plentiful. Descending westward, Conemaugh shale shows with an interbedded reddish stratum. |
| 106. | 186.2<br>**85.8** | West of New Alexandria, at top of grade, a cut exposes reddish-brown shale belonging in the Monongahela formation. |
| 107. | 188.1<br>**83.9** | West slope of Whitethorn Creek valley. Conemaugh sandstone and shale are encountered again. |
| 108. | 188.4<br>**83.6** | Conemaugh beds show between here and station 109, and are again seen at this point. |
| 109. | 200<br>**72** | West of Murrysville, a large cut at the county line continues up hill and exposes the Conemaugh shale with interbedded thin coals. |
| 110. | 205.5<br>**66.5** | Conemaugh beds show between here and station 109, and are again seen at this point. |
| 111. | 207.5<br>**64.5** | Top of rise, cuts. The higher Pennsylvanian beds are now encountered as shale and thin, interbedded sandstones assigned to the Monongahela formation. |
| 112. | 208.5<br>**63.5** | Entering Churchill from the east, cuts at the intersection of Routes 22 and 280 expose more of the Conemaugh sandstones and shales. Unusually heavy sandstone is shown. |
| 113. | 209<br>**63** | Across the valley from 112, the heavy sandstones of Station 112 are again seen. (See Bulletin G 17.) |
| 114. | 219<br>**53** | Passing through Pittsburgh via the Boulevard of the Allies, cuts expose the Monongahela sandstone and shale. A splendid view from the bluffs is had of the entrenched Monongahela River valley. |
| 115. | 221<br>**51** | After crossing the Monongahela River, the road runs along the south bank for some distance past the funicula railway. Here a large cut bank towering on the south exposes the Conemaugh series. Individual members may be recognized in this section. |
| 116. | 222.3<br>**49.7** | In Chartier, cuts. Upper Pennsylvanian, Monongahela, heavy sandstone and some shale are exposed. |
| 117. | 227.1<br>**44.9** | Moon Run. A cut in the Monongahela formation exposes the Benwood limestone. Thin limestones appear at intervals in the Pennsylvanian system in western Pennsylvania. Some are fresh-water formed and probably lenticular and of little areal extent. Others are marine, fossiliferous, wide-spread and of great value in correlation because of their importance as reliable datum surfaces. |

| | | |
|---|---|---|
| 131. | 228.5<br>**43.5** | The route here passes through a small oil field with its derricks. Cuts along the up-grade expose the Monongahela formation. |
| 132. | 229.5<br>**42.5** | Top of grade, two cuts show Monongahela beds. In the lower cut is shale; in the upper cut is shale and some knobby limestone. |
| 133. | 232<br>**40** | Intersection of Routes 22 and 30. The Upper Pennsylvanian, Monongahela shale with a little coal is exposed. |
| 134. | 232-272<br>**0-40** | The road travels west across the gradually descending level of the Allegheny Plateau toward the Pennsylvania-West Virginia line just west of Paris (262 miles) and finally crosses the Ohio River to Steubenville (272 miles), still in beds of Pennsylvanian age. |

## REFERENCES

The following list is by no means complete, but cites articles which should be available in most of the larger libraries in Pennsylvania. A complete list of publications may be had gratis from the State Geologist, Harrisburg, Pennsylvania. Topographic maps of the route are obtainable from the U. S. Geological Survey, Washington, D. C.

*Topographic maps crossed by the route described*

| | | |
|---|---|---|
| Philadelphia | New Cumberland | Hollidaysburg |
| Chester | Harrisburg | Ebensburg |
| West Chester | New Bloomfield | Johnstown |
| Coatesville | Millerstown | New Florence |
| Quarryville | Mifflintown | Latrobe |
| Norristown | Lewistown | Greensburg |
| Phoenixville | Mount Union | Pittsburgh |
| New Holland | Huntingdon | Carnegie |
| Lancaster | Allensville | Burgettstown |
| Middletown | Tyrone | Steubenville |

*Folios of the United States Geological Survey describing parts of the route*


110. Latrobe, M. R. Campbell, 1904.
133. Ebensburg, Charles Butts, 1905.
162. Philadelphia, F. Bascom, 1909.
174. Johnstown, W. C. Phalen, 1910.
223. Coatesville-West Chester, F. Bascom and G. W. Stose, 1932.


*Bulletins of the United States Geological Survey describing parts of the route*


318. Geology of the oil and gas fields in Steubenville, Burgettstown and Claysville quadrangles, Ohio, West Virginia and Pennsylvania, W. T. Griswold and M. J. Munn, 1907.
447. Mineral resources of Johnstown, Pennsylvania and vicinity, W. C. Phalen and Lawrence Martin, 1911.
456. Oil and gas fields of the Carnegie quadrangle, Pennsylvania, M. J. Munn, 1911.
799. Geology of the McCalls Ferry-Quarryville district, Pennsylvania, E. B. Knopf and A. I. Jonas, 1929.
840. Geology and mineral resources of the Middletown quadrangle, Pennsylvania, G. W. Stose and A. I. Jonas, 1933.
891. Geology and mineral resources of the Honeybrook and Phoenixville quadrangles, Pennsylvania, F. Bascom and G. W. Stose, 1938.

*Publications by the Pennsylvania Topographic and Geologic Survey*

N.B. These are publications of the *present* survey only. Those of the earlier surveys appearing since 1836 are usually available in the larger libraries. Particular attention is called to the county reports of the Second Pennsylvania Geologic Survey.

A27. Pittsburgh quadrangle, Meredith E. Johnson, 1928.
A37. Greensburg quadrangle, Meredith E. Johnson, 1926.
A168. Lancaster quadrangle, Anna I. Jonas and George W. Stose, 1930.
A178. New Holland quadrangle, Anna I. Jonas and George W. Stose, 1926.
G1. A syllabus of Pennsylvania geology and mineral resources, George H. Ashley, 1931.
G3. Pennsylvania caves, Ralph W. Stone, 1932.
G4. Devonian faunas in Pennsylvania, Bradford Willard, 1932.
G6. Scenery of Pennsylvania, George H. Ashley, 1933.
G7. Glacial deposits outside the Wisconsin terminal moraine in Pennsylvania, Frank Leverett, 1934.
G8. A paleozoic section in south-central Pennsylvania, Bradford Willard and Arthur B. Cleaves, 1938.
G17. Guidebook to geology about Pittsburgh, Henry Leighton, 1939.
M6. Bituminous coal fields of Pennsylvania, Parts I, II, III and IV, various authors, 1925-1932.
M15. Building stones of Pennsylvania, Ralph W. Stone, 1932.
M17. Clay and shale resources of southwestern Pennsylvania, Henry Leighton, 1933.
M19. Contributions to oil and gas geology of western Pennsylvania, J. D. Sisler, G. H. Ashley, F. T. Moyer and W. O. Hickok, 4th, 1933.
M20. Limestones of Pennsylvania, B. L. Miller, 1934.
W1. Ground water in southwestern Pennsylvania, Arthur M. Piper, 1933.
W2. Ground water in southeastern Pennsylvania, George M. Hall, 1934.
W5. Ground water in south-central Pennsylvania, S. W. Lohman, 1938.
Progress report 112. White clays of Pennsylvania, Henry Leighton, 1934.
Progress report 113. Pennsylvania geology summarized, Bradford Willard, 1935.
Geologic map of Pennsylvania, 1931.

# GEOLOGIC TIME TABLE FOR PENNSYLVANIA

| ERA | PERIOD | Approximate age in millions of years | GROUP OR FORMATION | Thickness in feet. | Abbreviated and generalized |
|---|---|---|---|---|---|
| CENOZOIC | Recent | 0 | Alluvium | Variable | River plain deposits, sand, gravel, clay, etc., terraces (in part) |
| | Pleistocene | 1 | Glacial deposits | Variable | Till, boulders, etc., and fluvio-glacial sediments |
| | | | Cape May | 40–60 | Sand, gravel, clay |
| | | | Pensauken | 5–250 | Sand, gravel, clay |
| | Pliocene | 1 | Bryn Mawr | 5–50 | Gravel, sand, clay |
| | Miocene | | Absent in Pennsylvania | | |
| | Oligocene | | Absent in Pennsylvania | | |
| | Eocene | | Absent in Pennsylvania | | |
| MESOZOIC | Cretaceous | | Doubtful in Pennsylvania | | |
| | Jurassic | | Absent in Pennsylvania | | |
| | Triassic | 170 | Brunswick (Gettysburg) | 1200 | Red shale, sandstone, and conglomerate |
| | | | Lockatong | 1800–3600 | Hard, black and red, calcareous shale (eastern Pennsylvania only) — Intruded by diabase, basalt, etc. |
| | | | Stockton (New Oxford) | 2300–3100 | Sandstone and conglomerate |

Interval of folding, faulting and erosion

| | | | | | |
|---|---|---|---|---|---|
| PALEOZOIC | Permian | 210 | Dunkard | 1150 | Sandstone, shale, coal, and blue stone (southern Pennsylvania only). |
| | Pennsylvanian | 250 | Monongahela | 300–400 | Limestone, shale, sandstone, Pittsburgh and other coals |
| | | | Conemaugh | 600–900 | Shale, sandstone, limestone and thin coals |
| | | | Allegheny | 300 | Sandstone, shale, clay, and thick coals. |
| | | | Pottsville | 100–200 | Massive sandstone, conglomerate, shale and thin coals. |
| | Mississippian | 280 | Mauch Chunk | 0–3000 | Red shale and sandstone |
| | | | Lovalhanna | 0–60 | Sandy, cross-bedded limestone |
| | | | Pocono | 700–1600 | Heavy-bedded, gray sandstone and conglomerate |
| | Devonian | 320 | Catskill (facies) | 0–4500 | Red shale, sandstone and arkose, conglomerates. Some green members in east. |
| | | | Chemung (*sensu lato*) | 1800–3000 | Gray, sandy shale and sandstone |
| | | | Portage | 1000–2500 | Green, gray and black shales to west, flaggy sandstone to east. Tully limestone at base in central Pennsylvania. |
| | | | Hamilton | 1000–1800 | Dark shale and sandstone, locally massive sandstone. Marcellus black shale at base |
| | | | Onondaga | 0–400 | Cherty and pure limestones and shale. Esopus shale at base in east. |
| | | | Oriskany | 0–335 | White to brown, coarse, friable sandstone and fine conglomerate and light-colored chert |
| | | | Helderberg | 0–300 | Gray to blue limestone and shale and limy shale |
| | Silurian | 350 | Tonoloway and Keyser | 450–800 | Hard, lumpy to thinly-laminated limestone |
| | | | Wills Creek | 450–750 | Thin-bedded, limy shale and shaly, impure limestone |
| | | | Bloomsburg (facies) | 400–1500 | Red shale and sandstone, occasional green beds |
| | | | McKenzie | 40–150 | Blue-gray, platy limestone and shale |
| | | | Rochester | 70–200 | Gray shale and limestone. Reefer sandstone in lower part |
| | | | Rose Hill | 700–800 | Thin-bedded, olive shale |
| | | | Clinton | 700–1000 | Sandy shale to red-brown shale, sandstone and iron ore beds |
| | | | Tuscarora or Shawangunk | 200–1800 | Heavy-bedded sandstone and conglomerate, gray to white |
| | Ordovician | 400–440 | Juniata | 0–1500 | Red sandstone and shale |
| | | | Bald Eagle | 0–1500 | Gray sandstone and conglomerate |
| | | | Martinsburg { Reedsville ("Trenton") | 1000–1500 500–600 | Dark gray to black [illegible] and conglomerate. Lab[illegible] lumpy, fine-grained limestone |
| | | | Chambersburg | 0–800 | Impure, lumpy limestone plus purer bed |
| | | | Stones River | 0–1000 | Very pure, fine crystalline, drab to dark gray limestone |
| | | | Beekmantown { Bellefonte | 1000± | Thin-bedded to massive, dolomitic limestone, often impure and cherty |
| | | | Axemann | 1000± | |
| | | | Nittany | 1000± | NOTE. The Beekmantown is sometimes referred to as "Canadian." |
| | Cambrian | 500 | Conococheague | 900–2000 | Pure to impure limestone and dolomite |
| | | | Elbrook | 2000–3000 | Fine-grained, cream to buff limestone and marble |
| | | | Waynesboro | 1000 | Gray to purple, sandy shale and sandstone and limestone |
| | | | Tomstown | 1000–1750 | Dark blue, knotty dolomite and impure limestone |
| | | | Harpers | 1200–3250 | Gray, banded quartzose phyllite or quartzite |
| | | | Chickies | 500–1500 | Massive white quartzite. Hellam conglomerate locally at base |
| ARCHEOZOIC | "Pre-Cambrian" | 1,000 | Wissahickon | ? | Oligoclase mica schist. Age disputed, may be Ordovician |
| | | | Baltimore | ? | Gray banded granitoid gneiss and hornblende schist. Age disputed. Unquestioned pre-Cambrian rocks known in eastern Pennsylvania |

*Pa*

N.B. Th
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A27. Pi

A37. Gr

A168. La

A178. Ne

G1. A
As

G3. Pe

G4. De

G6. Sc

G7. Gl
Fr

G8. A
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G17. Gu

M6. Bi
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M15. Bu

M17. Cl
193

M19. Co
G.

M20. Li

W1. Gr

W2. Gr

W5. Gr

Progress

Progress

Geologic

*A.* **Contorted Baltimore gneiss and pegmatite along the Schuylkill, Montgomery County.**

*B.* **Wissahickon gneiss at type locality along Wissahickon Creek.**

*A.* **Quarry in Chickies mica schist at Edge Hill, Montgomery County.**

*B.* **Railroad cut exposing Kinzers formation near the type locality in Lancaster County.**

***A.*** **Scene in the fertile limestone valley near Lancaster.**
The soil is particularly rich, and tobacco is an important crop.

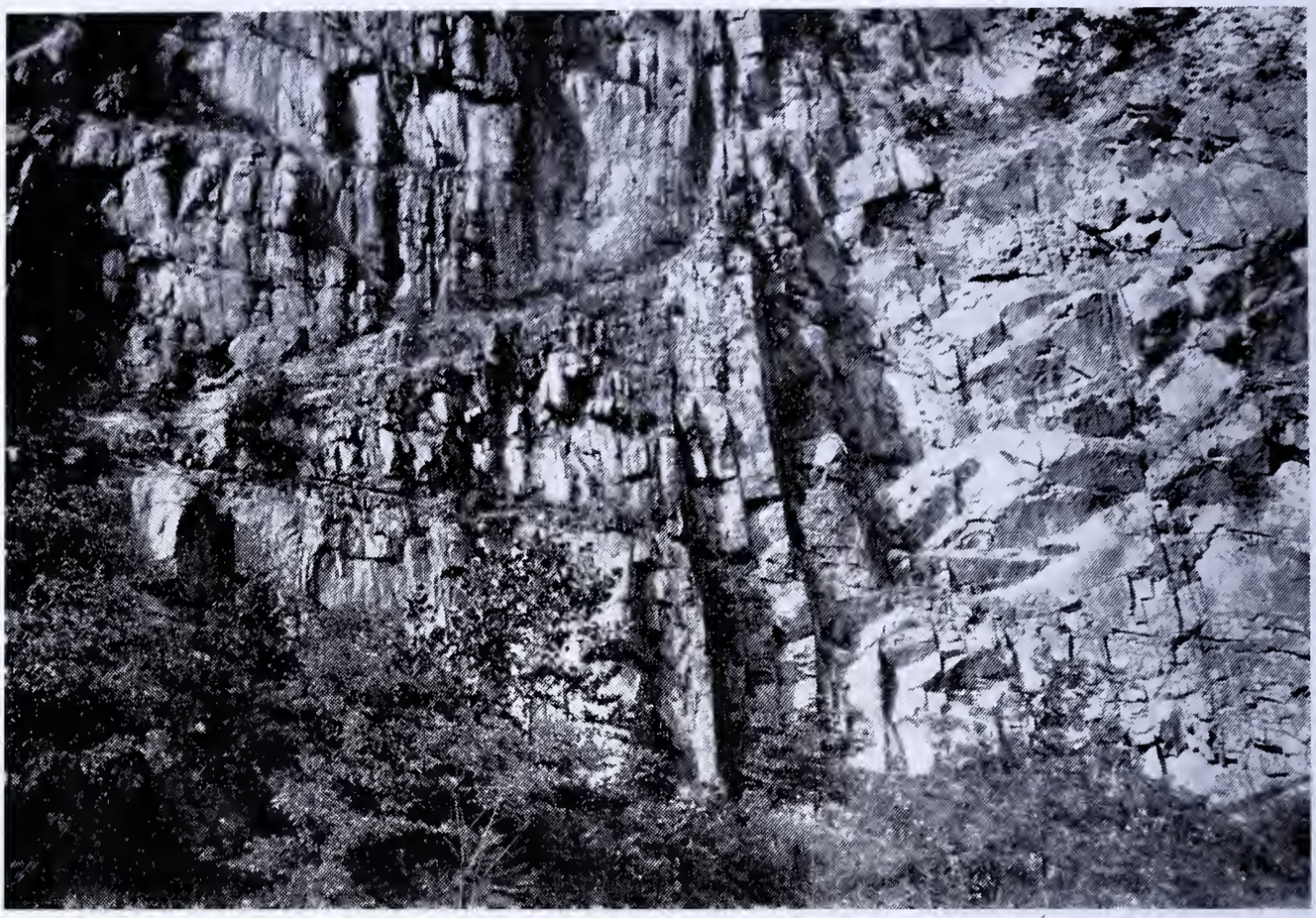
***B.*** **Triassic diabase boulders on Swatara Hill east of Middletown.**
These have frequently been mistaken for glacial deposits, but are actually formed in place through the weathering of the Triassic igneous rocks.

*A.* **Gravel pit in river terrace at Highspire.**

*B.* **Triassic red sandstone and conglomerate may be seen along the highway near Middletown.**

***A.*** **Italian Lake, Harrisburg.**
This is one of the many parks for which the capital city is famous.

***B.*** **The Susquehanna Valley above Harrisburg.**
Looking up river from the crest of Kittatinny Mountain. Little Mountain with Rockville quarries in center foreground, Second Mountain in middle distance, Peters Mountain in distance.



***A.*** **Middle Devonian (Montebello) sandstone in Rockville quarry, Little Mountain.**

***B.*** **Susquehanna Gap north of Harrisburg and the famous Stone Arch Bridge of the Pennsylvania Railroad.**

In the foreground at the river bank is some of the equipment of the "river coal" industry.

*A.* **The lower Portage shales and sandy shales are excessively folded south of Half Falls Mountain on the Juniata.**

*B.* **Second Mountain and river ledges of Pocono sandstone across the Susquehanna River from Dauphin.**

***A.*** **Along the Juniata River north from Amity Hall.**
The Catskill red beds are exposed in the cuts.

***B.*** **Between Amity Hall and Half Falls Mountain along the Juniata.**
A great cut exposes the Trimmers Rock sandstone of the Portage group.

*A.* **Clarks Ferry Bridge at the confluence of the Susquehanna (right) and the Juniata (left).**

*B.* **Southwest of Mifflintown a section along the river and railroad exposes closely folded Silurian strata, the "Rainbow Rocks."**

***A.*** **Juniata Narrows.**
The river passes hurriedly through a narrow gorge cut in Upper Ordovician and Lower Silurian formations.

***B.*** **The Juniata River near McVeytown.**
Here the river flows placidly through an open valley.

*A.* **At Mapleton the up-turned Oriskany sandstone of the Devonian has been extensively quarried for glass sand.**

*B.* **Terrace Mountain near Huntingdon takes its name from its profile as shown in this photograph.**

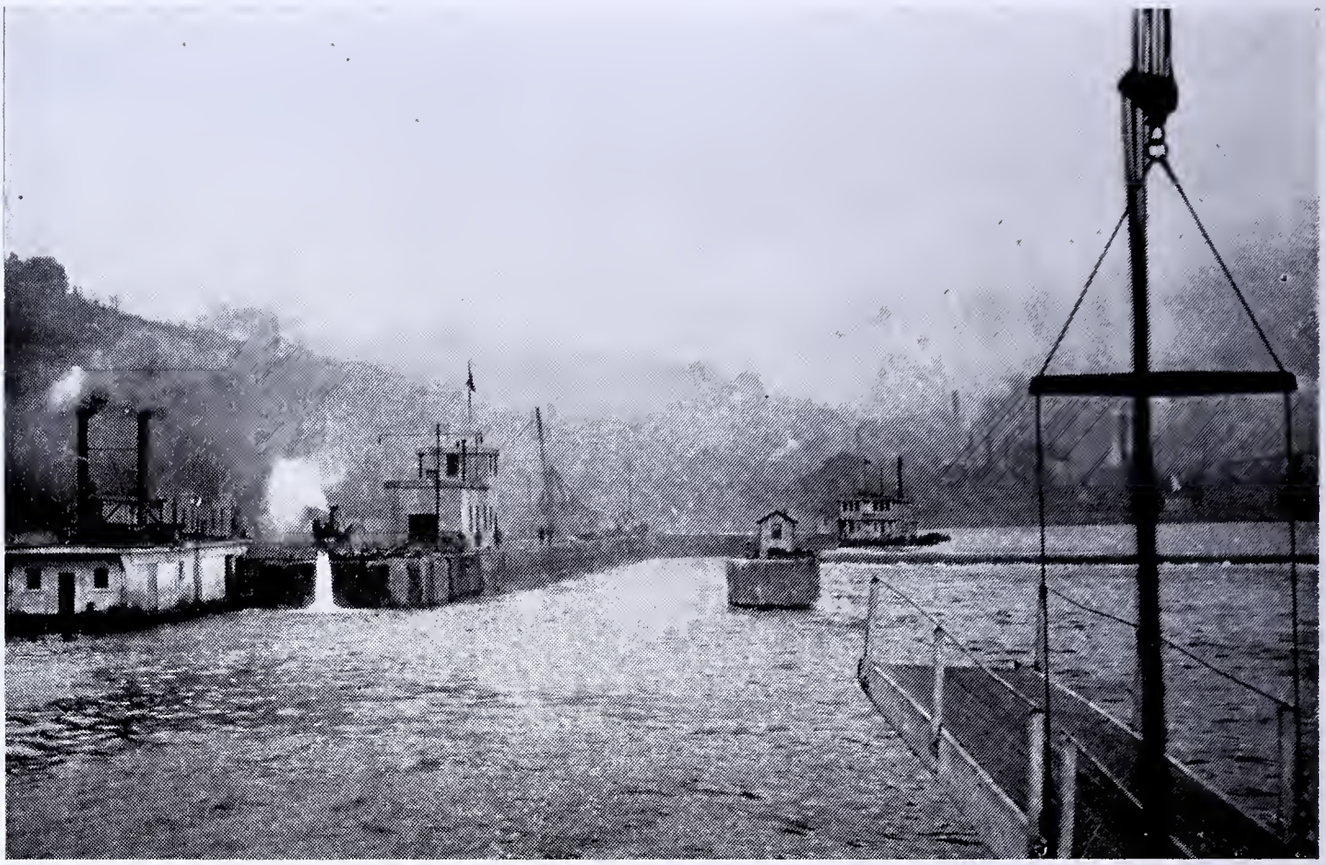
***A.*** **The road traverses a gap in Lock Mountain northeast of the village of Canoe Creek.**

***B.*** **Loyalhanna limestone.**

As the Allegheny Front is crossed, glimpses may be had of the extraordinarily cross-bedded Loyalhanna limestone or limy sandstone.

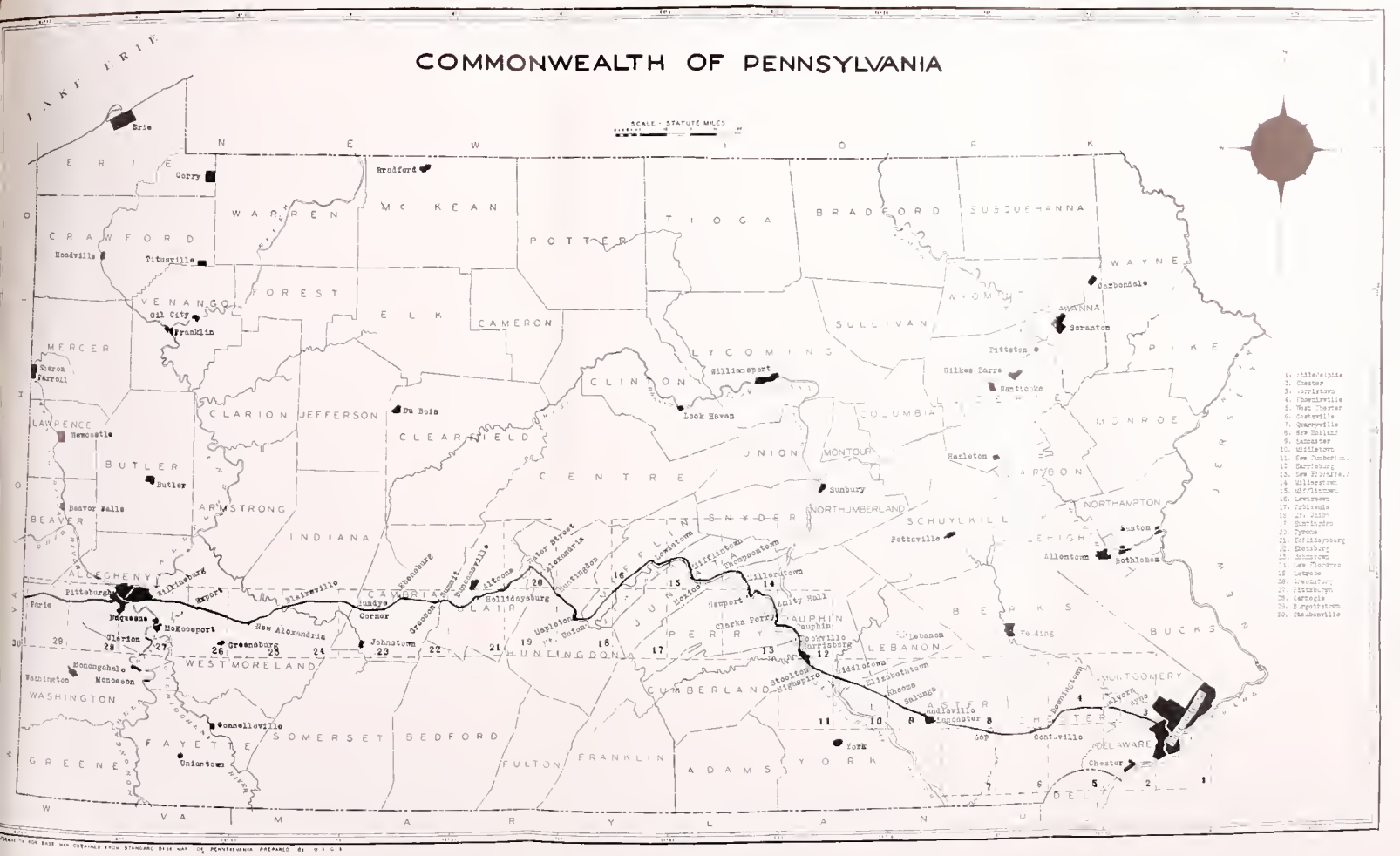
***A.*** **Plateau upland west of the Allegheny Front.**
This picture near Cresson, Cambria County, illustrates the character of the country.

***B.*** **Abandoned river channel in Pittsburgh.**
Valley that marks a former channel of Allegheny River near Carnegie Tech. campus.



***A.*** **Traffic on Monongahela River.**
Pittsburgh has long been noted for its river commerce.

***B.*** **Exposure of Conemaugh rocks at Brilliant Cut near Pittsburgh.**




Sketch map of route between Philadelphia and Pittsburgh